IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Weimer et al.

Patent No.: 6,963,101 B2

Issued: November 8, 2005

For: FILMS DOPED WITH CARBON FOR

USE IN INTEGRATED CIRCUIT

TECHNOLOGY

Attorney Docket No.: 2269-7415.4US

VIA ELECTRONIC FILING August 1, 2007

REQUEST FOR CERTIFICATE OF CORRECTION OF PATENT OFFICE MISTAKES (37 C.F.R. § 1.322)

Attn.: Certificate of Corrections Branch Commissioner for Patents P.O. Box 1450 Alexandria, VA 22313-1450

Sir:

It is noted that several errors appear in this patent of a typographical nature. These errors are due to mistakes in printing on the part of the U.S. Patent and Trademark Office, and occurred through no fault of the Applicants. A certificate of correction in the form attached hereto is requested.

Please note that an Amendment Pursuant to 37 C.F.R. § 1.312(a) (copy enclosed) was filed concurrently with the issue fee on August 31, 2005, but the amendments contained therein were apparently not completely entered before issuance of the patent. Attached is a copy of the previously filed Amendment Pursuant to 37 C.F.R. § 1.312(a) and the date-stamped postcard, acknowledging receipt by the PTO, to provide proof of such filing. We have included subject matter of this amendment on the attached PTO/SB/44 being suitable for printing.

Please send the Certificate to:

Name: Joseph A. Walkowski

Address: TraskBritt

P.O. Box 2550

Salt Lake City, Utah 84110

Attached hereto is Form PTO/SB/44 being suitable for printing.

Respectfully submitted,

Joseph A. Walkowski Registration No. 28,765 Attorney for Applicant(s)

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Date: August 1, 2007

JAW/csw

Enclosures: PTO/SB/44

Copy of Amendment Pursuant to 37 C.F.R. § 1.312(a)

Copy of date-stamped postcard

Document in ProLaw

Page 1 of 2

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

(Also Form PTO-1050)

UNITED STATES PATENT AND TRADEMARK OFFICE CERTIFICATE OF CORRECTION

PATENT NO : 6,963,101 B2

APPLICATION NO.: 1

10/789.981

ISSUE DATE

November 8, 2005

INVENTOR(S)

Ronald A. Weimer and John T. Moore

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the drawings:

In FIG. 4,

change element numeral "30" to --28--

In the specification:

COLUMN 8, LINE 26, change "integers **100** units" to --integers 100 units-change "integers **200** units" to --integers 200 units-change "deposition reactor" to --deposition (CVD) reactor--

In the claims:

CLAIM 2, COLUMN 11, LINE 5, change "to out" to --to about-CLAIM 2, COLUMN 11, LINE 7, change "20% a by" to --20% by-CLAIM 3, COLUMN 11, LINE 10, change "to out" to --to about-CLAIM 8, COLUMN 12, LINE 9, change "0% o about" to --0% to about-CLAIM 9, COLUMN 12, LINE 14, change "0% a about" to --0% to about--

MAILING ADDRESS OF SENDER (Please do not use customer number below):

Joseph A. Walkowski TRASKBRITT 230 South 500 East, Suite 300 Salt Lake City, Utah 84102 USA

This collection of information is required by 37 CFR 1.322, 1.323, and 1.324. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1.0 hour to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Attention Certificate of Corrections Branch, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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(Also Form PTO-1050)

UNITED STATES PATENT AND TRADEMARK OFFICE CERTIFICATE OF CORRECTION

PATENT NO

6,963,101 B2

Page 2 of 2

APPLICATION NO.:

10/789,981

ISSUE DATE

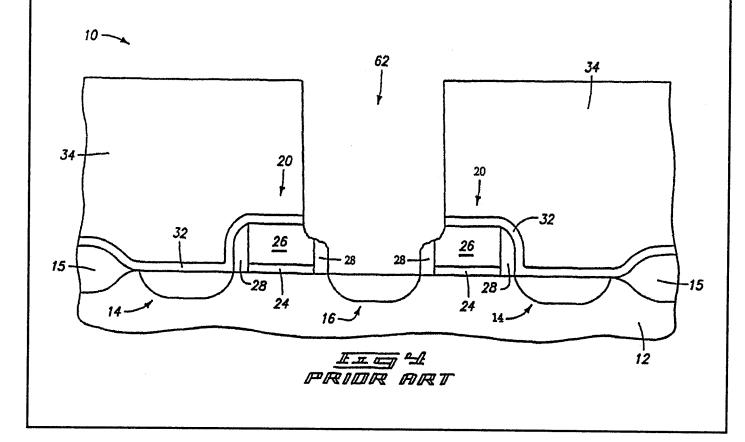
November 8, 2005

INVENTOR(S)

Ronald A. Weimer and John T. Moore

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Replace FIG. 4 with the following amended figure:



MAILING ADDRESS OF SENDER (Please do not use customer number below):

Joseph A. Walkowski TRASKBRITT 230 South 500 East, Suite 300 Salt Lake City, Utah 84102 USA

This collection of information is required by 37 CFR 1.322, 1.323, and 1.324. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1.0 hour to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Attention Certificate of Corrections Branch, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

THE PATENT & TRADEMARK OFFICE MAILROOM DATE STAMPED "EREON IS AN ACKNOW! EDGEMENT THAT C" "HIS ATENT & TRADEMARK-OFFICE RECEIVED: DATE TH

Transmittal Letter (2 pages, w/duplicate copy); Part B - Issue Fee Transmittal (1 page, w/duplicate copy); Check No. 830 m the amount of \$1,715.00; Amendment Pursuant to 37 C.F.R. § 1.312(a) (14 pages); with Replacement Sheet (1 sheet) Annotated Sheet (1 sheet); Comments on Statement of Reasons for Allowance (2 pages); and Fee Addressee for Receipt of PTOW Notices Relating to Maintenance Fees (2 pages).

Invention:

FILMS DOPED WITH CARBON FOR USE IN

INTEGRATED CIRCUIT TECHNOLOGY

Applicant(s):

Weimer et al. March 2, 2004

Filing Date: Serial No.:

10/789,981

Date Sent:

August 31, 2005 via Express Mail Label No.

EL994846043US

Docket No.:

2269-7415.4US

JAW/dlm:slm

TRASKBRITT DA

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Weimer et al.

Serial No.: 10/789,981

Filed: March 2, 2004

For: FILMS DOPED WITH CARBON FOR

USE IN INTEGRATED CIRCUIT

TECHNOLOGY

Confirmation No.: 9654

Examiner: C. Nguyen

Group Art Unit: 2811

Attorney Docket No.: 2269-7415.4US

(98-0551.04/US)

Notice of Allowance Mailed:

June 6, 2005

NOTICE OF EXPRESS MAILING

Express Mail Mailing Label Number: EL994846043US

Date of Deposit with USPS: August 31, 2005

Person making Deposit: Steve Wong

AMENDMENT PURSUANT TO 37 C.F.R. § 1.312(a)

Mail Stop ISSUE FEE Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450

Sir:

Please amend the above-referenced application as follows:

Amendments to the Specification begin on page 3 of this paper.

Amendments to the Claims are reflected in the listing of claims which begins on page 11 of this paper.

Amendments to the Drawings appear on page 13 of this paper and include both an attached replacement sheet and an annotated sheet showing changes.

Remarks begin on page 14 of this paper.

IN THE SPECIFICATION:

Please amend the first full paragraph on page 1 as follows:

This application is a Divisional of U.S. Patent Application No. 10/229,351, filed August 28, 2002, issued as U.S. Patent No. 6,713,807 on March 30, 2004, which is a Continuation of U.S. Patent Application No, 09/229,320 filed January 13, 1999, issued as U.S. Patent No. 6,462,371 on October 8, 2002, which claims priority to U.S. Provisional Application No. 60/109,925, filed November 24, 1998. This application is also related to U.S. Patent No. 6,162,737, issued on December 19, 2000.

Please amend the first full paragraph on page 2 as follows:

A possible mechanism by which selectivity can occur is through selective polymer formation on the protective material during etching of it- the protective material and the sacrificial material. For instance, etching of silicon oxide and silicon nitride under conditions such as those described in U.S. Patent No. 5,286,344 can create a carbonaceous polymer on the silicon nitride which protects the silicon nitride during etching of the silicon oxide. The carbon contained in the carbonaceous polymer can originate from, for example, etchant materials, such as gas, liquid or plasma materials, including, for example, CH₂F₂ and CHF₃. When silicon oxide, such as borophosphosilicate glass (also referred to throughout the specification as BPSG), is selectively etched relative to silicon nitride, the carbon will frequently originate at least in part from etching of the BPSG. Thus, less selectivity is obtained when less BPSG is etched relative to an amount of silicon nitride exposed to the etching conditions. Accordingly, thin layers of BPSG can be more difficult to etch than thick layers. Many selective etching methods are not effective for selectively etching BPSG relative to silicon nitride when the BPSG layers have thicknesses of less than or equal to about 1.3 microns.

Please amend the first full paragraph on page 4 as follows:

A bit line 50 extends over the second insulative layer 48 and is in electrical connection with the bit line contact 46. Accordingly, the bit line contact 46 electrically connects the bit line

50 to the node location 16. The bit line 50-ean may comprise, for example, aluminum, copper or an alloy of aluminum and copper.

Please amend the second full paragraph on page 4 as follows:

A method of forming the DRAM construction of Fig. 1 is described with reference to Figs. 2 and 3. Fig. 2 illustrates a semiconductive wafer fragment 10 at a preliminary processing step. The etch stop layer 32 extends over the wordlines 20, and over the node locations 14, 16. The insulative layer 34 extends over the etch stop layer 32, and a patterned photoresist masking layer 60 is provided over the insulative layer 34. The patterned photoresist masking layer 60 defines an opening 62 which is to be extended to the node location 16 for ultimate formation of the bit line contact 46 (shown in Fig. 1) therein.

Please amend the fifth full paragraph on page 4 as follows:

After the opening 62 is extended to the node location 16, the patterned photoresist masking layer 60 (shown in Fig. 2) can be removed, and subsequent processing used for forming the bit line contact 46 (shown in Fig. 1) within the opening 62. Also, similar etching described above to form the opening 62 for the bit line contact 46 can be used to form openings to the node locations 14 for formation of the capacitor constructions 36 therein. In the exemplified fabrication process, the opening 62 for the bit line contact 46 is formed prior to forming openings for the capacitor constructions 36 (shown in Fig. 1). However, other fabrication processes are known in the art wherein the openings for the capacitor constructions are formed either before, or simultaneously with, formation of the opening for the bit line contact.

Please amend the second full paragraph on page 5 as follows:

Fig. 4 illustrates a prior art problem that can occur as a result of the continued etching of the etch stop layer 32. Specifically, the etch stop layer 32 can become thinned to an extent that the spacers 28 are exposed to the etching conditions. Such exposure can lead to etching through the spacers 28 to expose the conductive layer 26. In a bad scenario, the conductive layer 26 is

shorted to the bit line contact 46 (shown in Fig. 1) when the conductive material of the bit line contact 46 is formed within the opening 62. Also, the thinning of the etch stop layer 32 can lead to unpredictability during a subsequent etch of the etch stop layer 32 to expose the node location 16. It is then unknown how long to continue a subsequent etch. If the etch continues for too long, the etch can undesirably penetrate into the substrate 12, and possibly through the diffusion region at the node location 16.

Please amend the first full paragraph on page 8 as follows:

As described in co-pending Application No. 09/175,051, filed October 9, 1998, now U.S. Patent No. 6,251,802, which issued June 26, 2001 (the disclosure of which is incorporated by reference herein in its entirety), the incorporation of carbon into a film can greatly reduce the etch rate of the film using an otherwise identical selective etch process. Without intending to be bound by any theory of the invention, it is believed that carbon increases the etch process selectivity by increasing the activation energy required by the etching process. An advantage of the relatively high activation energy films of the present-invention, relative to the lower activation energy films of the prior-art_art, is that lower activation energy films generally require more selective processes than do higher activation energy films. As processing conditions become more highly selective, the processing conditions tend to become less stable. Accordingly, since the carbon can allow for less selective processing conditions to be used to accomplish similar results as obtained in the prior art using more highly selective processing conditions, the present invention can allow for more robust processing conditions to be used than can be used by the prior art. Also, the present invention can increase a "process window," to further increase stability of the processing conditions. In other words, the carbon incorporation of the present invention can enable a selective process to occur across a broader range of conditions than such process would occur using prior art methods.

Please amend the third full paragraph on page 9 as follows:

An etch stop layer 132 is formed over the substrate 112 and over the wordlines 120. The etch stop layer 132 of the present invention is a film formed by combining a silicon-comprising material with a carbon-comprising material and at least one oxidizing agent. Portions of the etch stop layer 132 extend along the spacer spacers 128. The etch stop layer 132 can be formed to a thickness of less than about 1500 angstroms, preferably less than or equal to about 500 angstroms.

Please amend the paragraph bridging pages 9 and 10 as follows:

The etch stop layer 132 can be formed by, for example, chemical vapor deposition (CVD) of a silicon-comprising material in the presence of a carbon-comprising material and at least one oxidizing agent. Preferably the silicon-comprising material is silicon nitride and/or silicon oxide. The silicon oxide can be, for example, silicon oxide or BPSG. Alternatively, the silicon-comprising material can be BTBAS. Preferably the carbon-comprising material is TEOS and/or BTBAS, more preferably BTBAS. The carbon is preferably incorporated into the film in the form of silicon carbide (SiC). The oxidizing agent is preferably an oxide and/or an oxynitride, such as, for example, N₂O, O₂ and/or O₃.

Please amend the first full paragraph on page 10 as follows:

The etch stop layer 132 can be deposited, for example, in a chemical vapor deposition (CVD) reactor having a pressure of about 50 mTorr to about 10 Torr, a temperature of about 400° C to about 750° C, an SiH₄ flow rate of about 0 to about 500 sccm, an N₂O flow rate of about 0 to about 1000 sccm, an O₂ flow rate of about 0 to about 1000 sccm, and a BTBAS flow rate of about 0 to about 500 sccm, to form an etch stop layer 132 having a composition as described below.

Please amend the second full paragraph on page 10 as follows:

In another embodiment, carbon can be incorporated into the etch stop layer 132 by doping the etch stop layer 132 with carbon after deposition of the etch stop layer 132. Doping can be conducted by methods known in the art, including, for example, ion implanting with a carbon-comprising material or vapor annealing with a carbon-comprising material.

Please amend the paragraph bridging pages 10 and 11 as follows:

Referring to Fig. 6, an insulative layer 134 is formed over the etch stop layer 132 and an opening 162 is etched into the insulative layer 134 to stop at the etch stop layer 132. The insulative layer 134 can comprise, for example, BPSG. The opening 162 is defined by, for example, a patterned photoresist masking layer, as described in reference to Fig. 2 above. The sides of the opening 162 are aligned with portions 118 of the etch stop layer 132 that extend along the spacer spacers 128. The insulative layer 134 and opening 162 can be formed by methods discussed in the background section of the specification. The carbon incorporated in the etch stop layer 132 can greatly increase the selectivity of the etch of the insulative layer 134 relative to the etch stop layer 132. Such selectivity can decrease the risk of the prior art over-etch problems illustrated in Fig. 4. The decreased risk of over-etch problems accomplished by carbon incorporation in the etch stop layer 132 allows the etch stop layer 132 to be formed thinner than the etch stop layer 32 used in the prior art. Accordingly, there can be more space above the etch stop layer 132 for circuit constructions. Also, the incorporation of carbon in the etch stop layer 132 allows for etch selectivity to be obtained even if the insulative layer 134 is very thin before the etch. For example, the insulative layer 134 can be less than 1.3 microns thick before the etch and etch selectivity can still be obtained. Additionally, the incorporation of carbon in an etch stop layer that comprises silicon and oxygen provides an etch stop layer with a lower dielectric constant.

Please amend the first full paragraph on page 11 as follows:

After the selective etch to expose the etch stop layer 132, further processing can be used to extend the opening 162 to the node <u>location</u> 116. Such further processing can include a silicon nitride etch, such as, for example, hot phosphoric acid.

Please amend the second full paragraph on page 12 as follows:

The spacers 228 extend along the sidewalls of the wordlines 220. The cap layer 230 overlays the conductive layer 226 of the wordlines 220. The spacers 228 and cap layer 230 are a film formed by combining a silicon-comprising material with a-carbon-comprising material and at least one oxidizing agent. Preferably the silicon comprising material is silicon nitride and/or silicon oxide. The silicon oxide can be, for example, silicon oxide or BPSG. Alternatively, the silicon-comprising material can be BTBAS. Preferably the carbon-comprising material is TEOS and/or BTBAS, more preferably BTBAS. The carbon is preferably incorporated into the film in the form of silicon carbide (SiC). The oxidizing agent is preferably an oxide and/or an oxynitride, such as, for example, N₂O, O₂ and/or O₃.

Please amend the third full paragraph on page 12 as follows:

The spacer spacers 228 and cap layer 230 can be formed, for example, by chemical vapor deposition (CVD) using the reaction conditions described above for the etch stop layer 132 of the present invention.

Please amend the fourth full paragraph on page 12 as follows:

In another embodiment, carbon can be incorporated into the spacer spacers 228 and/or cap layer 230 by doping the spacer spacers 228 and/or cap layer 230 with carbon after deposition of the spacer spacers 228 and/or cap layer 230. Doping can be conducted by methods known in the art, including, for example, ion implanting with a carbon comprising material or vapor annealing with a carbon-comprising material.

Please amend the fifth full paragraph on page 12 as follows:

In the present invention, the spacer and/or cap layer comprises silicon, carbon and oxygen, and, optionally, nitrogen. In one embodiment, the spacer and/or cap layer can comprise about 20% to about 65% by weight silicon, about 2% to about 20% by weight carbon, about 5% to about 75% by-weighs: weight: oxygen and about 0% to about 30% by weight nitrogen.

Please amend the fourth full paragraph on page 13 as follows:

An opening 262 is etched through insulative layer 234 and to the substrate 212. The opening is defined by, for example, a patterned photoresist masking layer, as described above in reference to Fig. 2. The opening 262 is aligned relative to the spacer 228 proximate the substrate 212. In one embodiment, the insulative layer 234 comprises BPSG and the spacer spacers 228 and cap layer 230 comprise silicon nitride. In this aspect of the invention, a first silicon oxide layer (BPSG insulative layer 234) is etched selectively relative to a second silicon nitride layer (the layer of one or more of the spacers 228 and/or cap layer 230) by virtue of the carbon that has been incorporated/ doped into the second layer that comprises silicon and oxygen.

Please amend the second full paragraph on page 14 as follows:

Even if an etch stop layer is present, the spacers 228 can be thinner than the prior art spacers 28 to provide additional room for capacitor constructions. Specifically, a function of the prior art spacers 28 can be to provide a barrier in the event that etch stop layer 32 is etched through during processing to form opening 62. As the spacers 228 of the present invention are more resistant to etching than the prior art spacers 28, the spacers 228 can be formed thinner than prior art spacers 28 and still form an effective barrier against etch-through. For instance, prior art spacers 28 would typically be formed to a thickness of at least about 900 angstroms (the "thickness" being defined as an amount by which the spacers extend outwardly or horizontally from the sidewalls of the wordlines). The spacers 228 and/or cap layer 230 of the present

invention can be formed to a thickness of less than or equal to about 500 angstroms, preferably less than or equal to about 100 angstroms. The thinner spacers 228 can provide additional room for capacitor construction relative to the room available for capacitor construction in the prior art. Additionally, the incorporation of carbon in the films that comprise silicon and oxygen provides spacers and cap layers with a lower dielectric constant.

Please amend the second full paragraph on page 15 as follows:

A-An etch-resistant film was prepared in a chemical vapor deposition (CVD) reactor under the following conditions: a pressure of about 500 mTorr, a temperature of about 575° C, an N_2O flow rate of about 50 sccm, an O_2 flow rate of about 50 sccm, and a BTBAS flow rate of about 125 sccm. The resulting film had a stoichiometric composition of $SiO_{1.4}N_{0.2}C_{0.1}$, and a thickness of about 1040 angstroms.

Please amend the third full paragraph on page 15 as follows:

An etch-resistant film was prepared in a chemical vapor deposition (CVD) reactor under the following conditions: a pressure of about 500 mTorr, a temperature of about 575° C, an N_2O flow rate of about 150 sccm, and a BTBAS flow rate of about 125 sccm. The resulting film had a stoichiometric composition of $SiO_{1.3}N_{0.5}C_{0.3}$ and a thickness of about 630 angstroms.

IN THE CLAIMS:

Claims 1-5 and 9-14 were previously cancelled. Claims 6, 15 and 18 have been amended herein. All of the pending claims are presented below. This listing of claims will replace all prior versions and listings of claims in the application. Please enter these claims as amended.

Listing of Claims:

- 1.-5. (Cancelled)
- 6. (Currently amended) A capacitor assembly comprising comprising:
 a storage node extending within an insulative layer, wherein the storage node is next to a layer comprising silicon, about 2% to about 20% by weight carbon and about 5% to about 75% by weight oxygen;

a second electrode proximate the storage node; and a dielectric layer between the storage node and the second electrode.

- 7. (Original) The capacitor assembly of claim 6, wherein the storage node is next to a layer comprising about 20% to about 65% by weight silicon, about 0% to about 30% by weight nitrogen, about 10% to about 20% by weight carbon, and about 5% to about 25% by weight oxygen.
- 8. (Original) The capacitor assembly of claim 6, wherein the storage node is next to a layer comprising about 20% to about 65% by weight silicon, about 0% to about 15% by weight nitrogen, about 2% to about 10% by weight carbon, and about 40% to about 75% by weight oxygen.

9.-14. (Cancelled)

- 15. (Currently amended) An assembly comprising: a substrate;
- a layer comprising silicon, about 2% to about 20% by weight carbon and about 5% to about 75% by weight oxygen; and a photoresist masking layer.
- 16. (Original) The assembly of claim 15, wherein the layer comprises about 20% to about 65% by weight silicon, about 10% to about 20% by weight carbon, about 5% to about 25% by weight oxygen and about 0% to about 30% by weight nitrogen.
- 17. (Original) The assembly of claim 15, wherein the layer comprises about 20% to about 65% by weight silicon, about 2% to about 10% by weight carbon, about 40% to about 75% by weight oxygen and about 0% to about 15% by weight nitrogen.
- 18. (Currently amended) The assembly of claim 15, wherein the photoresist masking layer is a patterned photoresist masking layer.
- 19. (Previously presented) The assembly of claim 15, wherein the substrate is a monocrystalline wafer.
- 20. (Previously presented) The capacitor of claim 6, wherein the storage node comprises conductively doped silicon.
- 21. (Previously presented) The capacitor of claim 6, wherein the insulative layer comprises silicon oxide or silicon nitride.
- 22. (Previously presented) The capacitor of claim 6, wherein the dielectric layer comprises silicon dioxide or silicon nitride.

IN THE DRAWINGS:

The attached sheet of replacement drawings includes a change to FIG. 4. This sheet replaces the original sheet including FIG. 4.

Specifically, FIG. 4 has been revised to change the reference numeral "30" to --28--, as shown in he attached annotated drawing sheet. No new matter has been added.

REMARKS

This amendment corrects errors in the text. Entry is respectfully solicited.

This amendment is submitted prior to or concurrently with the payment of the issue fee and, therefore, no petition or fee is required. No new matter has been added.

Respectfully submitted,

Joseph A. Walkowski Registration No. 28,765

Attorney for Applicant(s)

TRASKBRITT P.O. Box 2550

Salt Lake City, Utah 84110-2550

Telephone: 801-532-1922

Date: August 31, 2005

JAW/csw

Enclosures: Replacement Sheet

Annotated Sheet Showing Changes

 $\label{locs} $$ \operatorname{DOCS}_{2269-7415.4US}_{128277.doc} $$$

